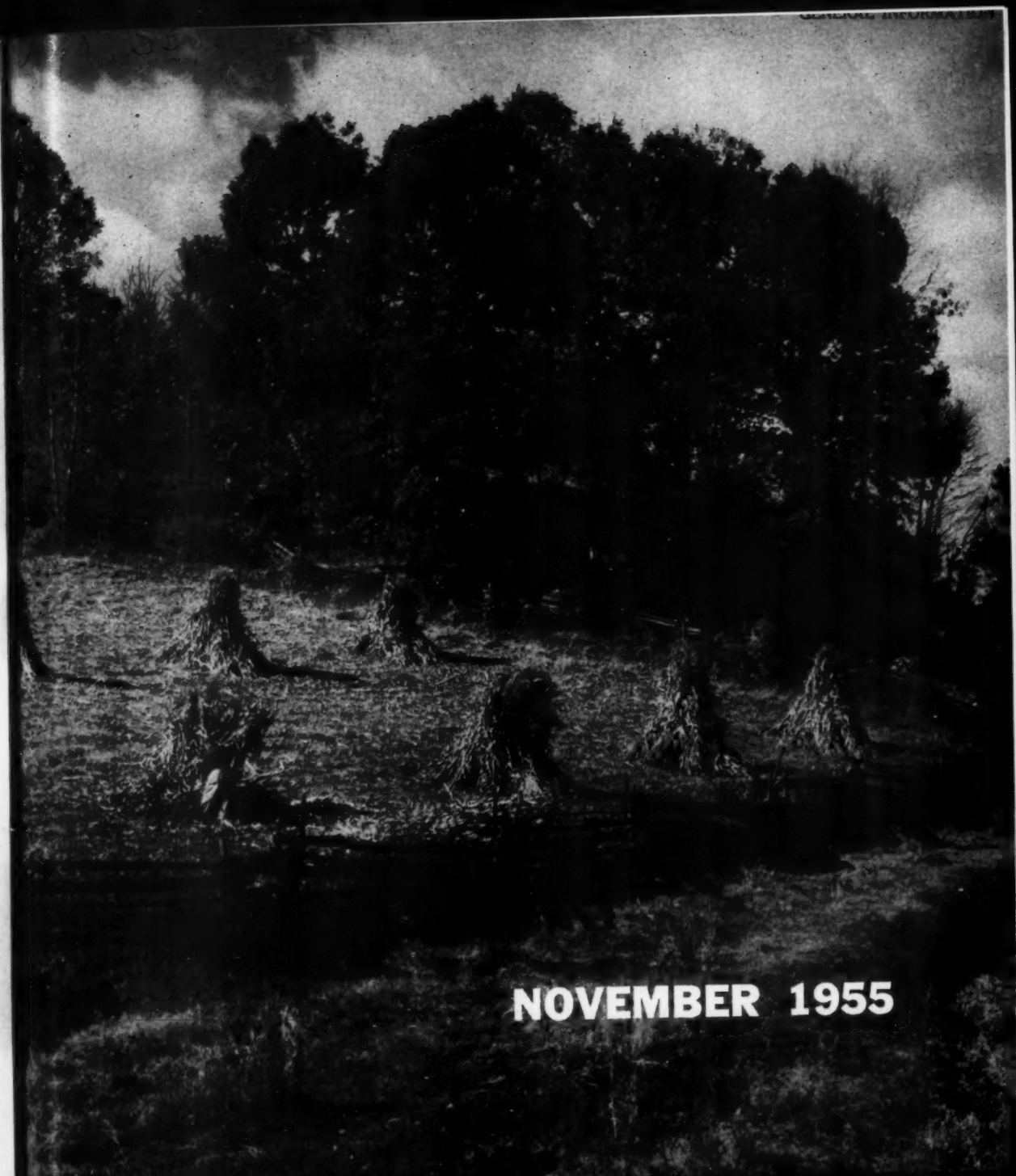

NOVEMBER 1955

SOIL CONSERVATION

Soil Conservation Service • U. S. Department of Agriculture

SOIL CONSERVATION

NOVEMBER 1955

VOL. XXI—NO. 4

EZRA TAFT BENSON
SECRETARY OF AGRICULTURE

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ADMINISTRATOR, SOIL CONSERVATION SERVICE

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★ THIS MONTH ★

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WELLINGTON BRINK
Editor

SOIL CONSERVATION is published by direction of the Secretary of Agriculture as administrative information required for proper transaction of the public business. The printing of this publication has been approved by the Bureau of the Budget, July 18, 1955. SOIL CONSERVATION supplies information for workers of the Department of Agriculture and others engaged in soil conservation.

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HORSES AND CONSERVATION.—Although USA's farm horse population dropped 800,000 between 1954 and 1955, equine employment remained steady in many areas where the lush grasses of soil conservation farming are increasing in use.

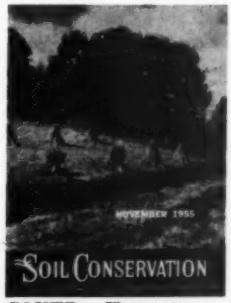
For example, densely populated New Jersey has maintained 7,000-horse prosperity during the past year, feeding mainly on grass, legume, and small grain seeded on fields to restore soil vigor and moisture.

Horses are still useful in New Jersey. One acre of grassed waterway yields enough hay to support one horse a year.

Chief mainstay of the horses, however, the the permanently sodded waterways, terraces, outlets, and pond spillways. Mowed regularly to hold down weeds and prevent erosion, they mean plenty of high quality hay for Ol' Dobbin. Garden State farmers look warmly at this as another "conservation extra."

(Continued on page 82)

Editors are invited to reprint material originating in this magazine.



FRONT COVER.—Harvest scene on the farm of Lester Dodson, Sperryville, Va.

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Flood Program—How Effective?

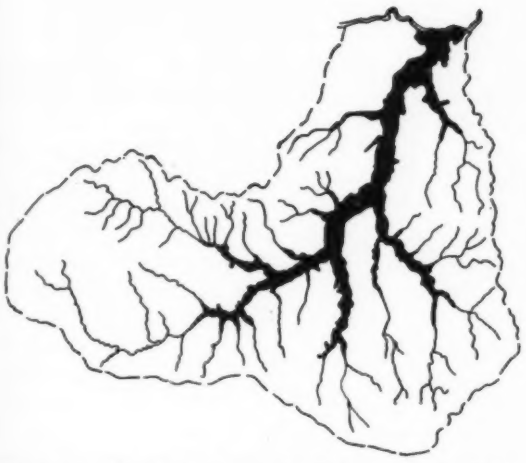


Figure 1.—Flood plain on Sandstone Creek, Okla., 4,700 acres. The Hammon flood of 1934 inundated the entire flood plain.

By H. N. HOLTAN

MANY PERSONS may have wondered just what the Department of Agriculture's flood reduction program is all about. This article is intended to provide a brief summary of the Department's responsibilities in this program, the methods it is using in attacking the flood problem, and some evidence of the effectiveness achieved.

Public Law 566 became effective August 4, 1954. It authorized a permanent program by which the Department of Agriculture provides technical and financial assistance to local watershed groups willing to assume responsibility for initiating, carrying out, and sharing the costs of upstream watershed conservation and flood control. The Soil Conservation Service was designated as the action agency with primary responsibility for the Department's cooperation with local organizations in small watersheds throughout the nation.

The Service, of course, has been working on phases of flood control since the Omnibus Flood Control Act of 1936, and under the Flood Control Act of 1944 (Public Law 534) it has been applying special treatment for flood control on 11 watersheds embracing nearly 16 million acres of farmland in 12 states. The operations there are carried on in cooperation with soil conservation districts and other local and state organizations. The Service also has been conducting investigations on other watersheds in cooperation with the Forest Service, to determine whether flood control measures would produce benefits in excess of costs, and to develop remedial programs.

Flood reduction programs, as laid out by the Soil Conservation Service, are aimed at (1) proper land use and treatment, and (2) the controlled conduction and discharge of runoff water.

Land use and treatment measures are planned in accordance with the Service purpose of achieving "the use of each acre of agricultural land within its capabilities and the treatment of each acre of agricultural land in accordance with its needs for protection and improvement." The effect is to increase the economic returns of a farm and at the same time reduce erosion and sedimentation damages downstream.

Runoff flows are controlled, safely conducted, and discharged from the watershed by a care-

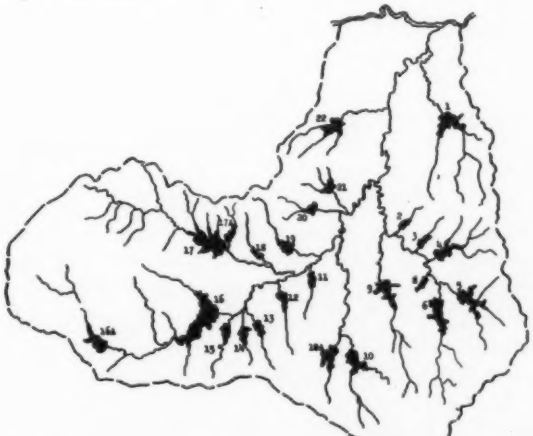


Figure 2.—Detention reservoirs installed on Sandstone Creek, Okla.; completed in 1951.

Note.—The author is a hydraulic engineer, central technical unit, Soil Conservation Service, Beltsville, Md.

fully designed combination of detention reservoirs and channel capacities. The system functions like an undersized road culvert beneath a high fill because runoff water is held in the reservoir and released at a predetermined rate through tubes passing through or beneath the dam. The release rate is selected according to the in-bank capacity of the downstream channel. Sometimes it is feasible to increase the capacity of the channel by straightening, by enlargement, by levees, or by other means. Occasionally, a detention reservoir may even be eliminated or cut down in size by substitution of a greater release rate. This is a limited practice, however, since speeding the flow through a section of stream may cause overloading and flooding at some point downstream.

To eliminate all flooding, the location, size, and release rate of reservoirs in a system must be kept in balance with downstream channel capacities. Economic balance imposes a further consideration upon any flood-reduction program. It may not be economically justifiable to eliminate all flooding. Areas having small potential value would not justify important expenditures for protection. Furthermore, there is a point of diminishing returns which determines the maximum size storm for which complete protection should be provided. Although damages multiply as storm-size increases, the recurrence interval may lengthen out until it finally becomes so great that the value of protection fails to justify the increase in cost.

Three questions present themselves prior to planning a program:

1. What type and amounts of precipitation should be anticipated?
2. What volumes of runoff will be produced by each precipitation?
3. What peak flows will result?

When these have been satisfactorily answered, only one other question remains: What combination of measures will afford the most protection with the most favorable ratio of benefit to cost? This may appear to involve pure speculation but actually there is a considerable amount of factual information on which to base our calculations. Procedures are by no means simple, but the rudiments of our determinations can be stated briefly for watersheds where rainfall and streamflow records are available.

The U. S. Weather Bureau records of past precipitation (or records from other reliable sources) are studied to determine the average recurrence interval of various types and amounts of rainfall for an area. Just as insurance companies base their expectancies on past experience, so hydrologists base their anticipations of future storms on the records of past precipitation.

The U. S. Geological Survey records of streamflow are studied to determine the average relationship between amount of precipitation and volumes of runoff. Peak rates of flow are also correlated with precipitation from these same records.

At various points on the stream, within the watershed, peak flows and areas inundated are determined from highwater marks of the more recent floods. These marks are obtained and substantiated by personal interviews with local residents, by visible evidence, and by mathematically routing various flows through the channel system. Thus, the average relationship between peak flows and areas inundated is determined.

These relationships permit estimates of the area inundated, if any, by each precipitation and, subsequently, the extent and average recurrence interval of such inundations to be expected in the future. Economic and agricultural surveys of the flood plain are applied toward the evaluation of damages from inundations expected at various frequencies.

Various combinations of detention reservoirs and channel works are considered as to their individual and combined effect upon downstream flows and damages. The average annual cost and the average annual benefits (damage reduction) of each combination are compared. Generally, the program is developed to that degree of control where further measures to reduce damages would result in uneconomical additions to the cost. Quite often it is not possible to arrive at this exact point due to unavailability of needed reservoir sites and easements, and to economic limitations.

Have any of these flood-control programs been tested in operation, and did they prove out as planned? The Soil Conservation Service is

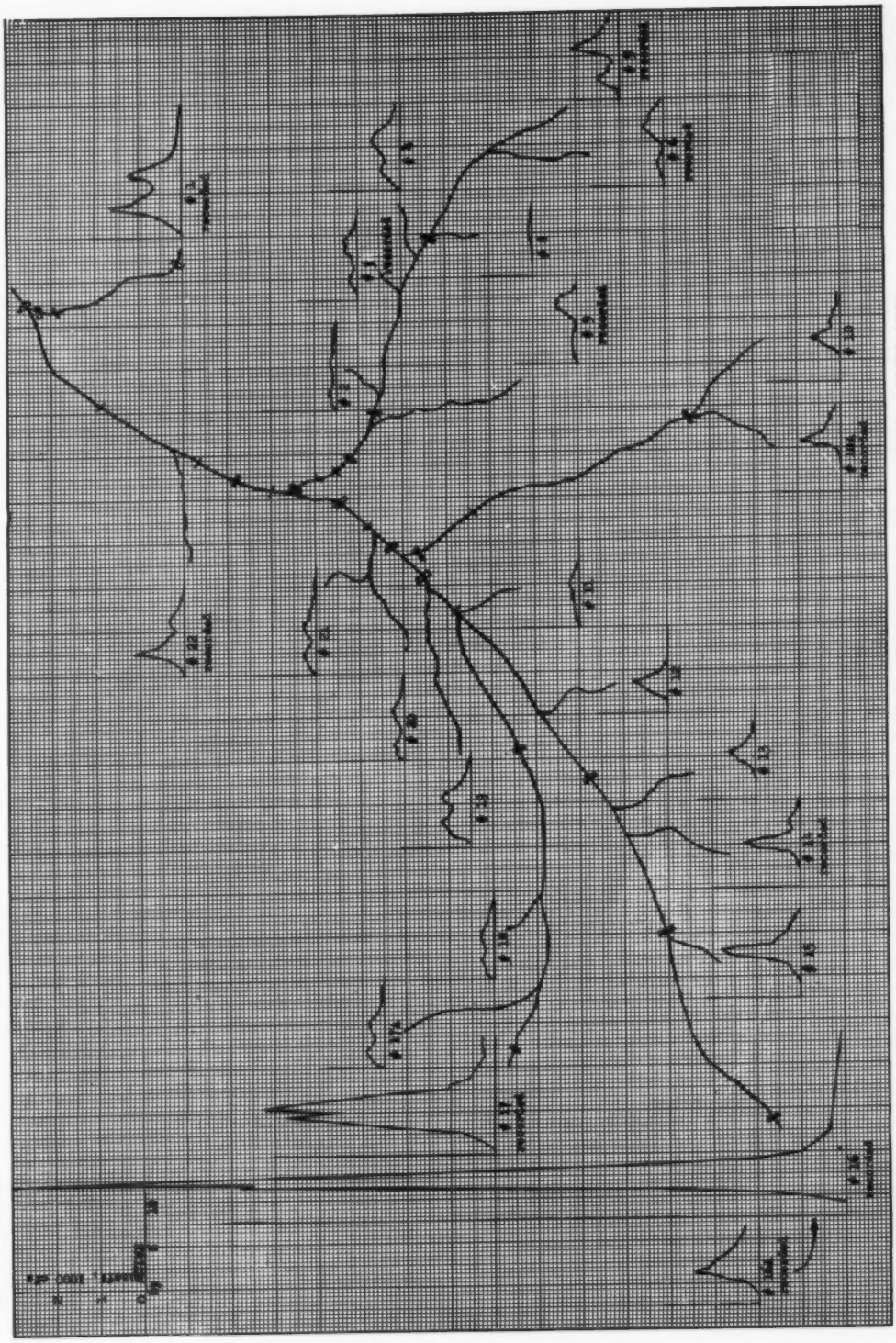


Figure 3.—Hydrographs of inflow to reservoirs during the storm of May 23-24, 1954.

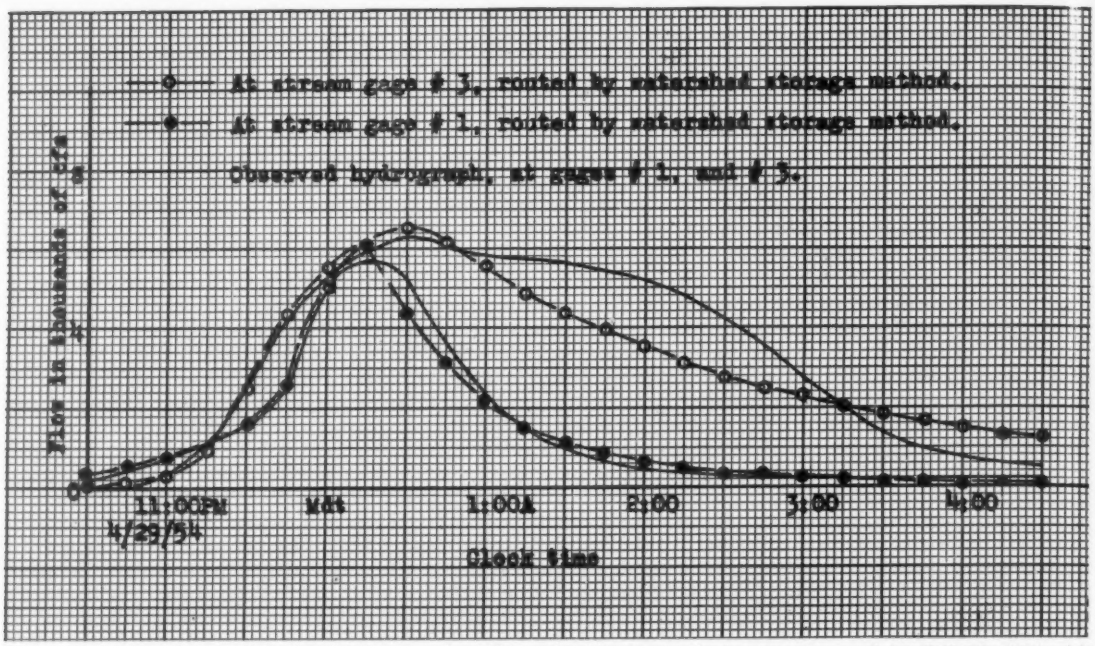


Figure 4.—Comparison of derived hydrographs with actual hydrographs for the storm of April 29-30, 1954 with reservoirs.

intent on obtaining dependable evidence of the validity of its flood-reduction planning procedures. Selected watersheds upon which flood-reduction programs have been installed were equipped with recording instruments to permit detailed determinations of rainfall, runoff, and inundations over the entire watershed. Sandstone Creek in Oklahoma is one of the watersheds thus equipped.

Sandstone Creek lies within a rectangle formed by the towns of Sayre, Elk City, Hammon, and Cheyenne. It flows in a northearterly direction for 15 miles. It enters the Washita River about 8 miles southwest of Hammon. The watershed varies from 2 to 11 miles in width, averaging about 6 miles. It has an area of 65,013 acres, all of which is in farms or rangeland. There are 4,700 acres of flood plain. (Figure 1.) The Sandstone vicinity is characterized by high intensity rains in spring, summer, and fall. Average annual rainfall is 25 inches, approximately 30 percent of which comes in May and June and 11 percent in September. On the average, 79 percent of the annual rainfall comes during the growing season of April to October.

During 20 years, 1920 through 1939, flooding occurred 184 times—an average of 9 times per year. Damage ranged from slight for small floods to disaster proportions in the 1934 flood when the entire flood plain was inundated. This period included the great drought of the early thirties and three spectacular floods. In the Hammon flood of April 1934 the Sandstone Creek watershed received 11 inches of rainfall with 8 inches falling in 2 days.

The flood reduction program on Sandstone Creek was completed in the early fifties. The program consisted of proper land use and treatment measures, channel improvements and stabilization measures, and 24 detention reservoirs located as shown in Figure 2. Through the use of stage recorders, records of inflow and outflow were obtained on 11 of the 24 reservoirs and records of streamflow were obtained at 3 strategic points in the channel system. Crest gages were installed to permit accurate determinations of maximum stages and subsequent inundations along the entire length of the flood plain. These installations were designed to provide accurate measurements of what actually happens during a

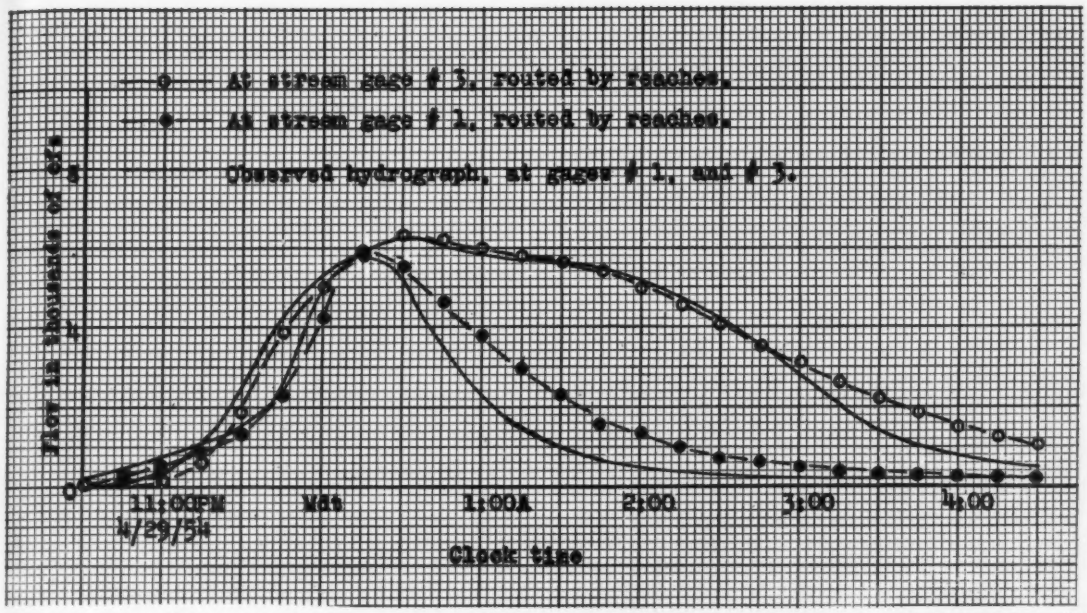


Figure 5.—Comparison of derived hydrographs with actual hydrographs for the store of April 29-30, 1954 with reservoirs.

storm. They were also designed to provide data on rates and volumes of runoff produced on various portions of the watershed. Such data provide factual bases for determining the flows and subsequent inundations which would have occurred if the program had not been installed.

Following 2 dry weeks, the Sandstone watershed received an average of 4 inches of rainfall on April 25, 27, and 29, 1954. The heaviest storm was on the 29th. A succession of rains totaling about 3.4 inches came during the first half of May. Then, on May 23 and 24, an average of 4.36 inches fell. The storms of April 29 and May 23 were of such intensity and magnitude that severe flooding would have been expected if the flood reduction program had not been in effect.

Speculation ran high during these heavy storms. Local venerables began to draw comparisons with the "big one" of 1934. Farmers who had planted flood plain lands to high-value crops on the strength of the flood reduction program watched anxiously and with fingers crossed as the downpour continued. At the cessation of each storm, the Sandstone was a beehive of activity. Farmers viewed their fields to check on damages, news reporters came out for pictures and stories, and curiosity drew many others. Soil Conservation Service technicians were busy running various fact-finding surveys. Employees of the U. S. Weather Bureau and U. S. Geological Survey collected records of rainfall and runoff.

Local interests were pleased to learn that the April storm had flooded 588 acres and the May storm only 200 acres. Soil Conservation technicians dug out the original estimates prepared during the development of the program's plan. Original estimates for storms of these sizes were: 410 acres inundated for the April storm and 310 for the May storm! The errors were trifling and well within the limits of human frailty—but why was the April estimate too low and the May estimate too high? Post-storm surveys had indicated a serious logjam at one of the road bridges during the April storm. This had backed up some water. Rainfall records indicated a concentration of rainfall on those areas lying below the reservoirs. Conversely, during the May storm concentrations of rainfall occurred above the reservoirs, thus affording the moderating influence of reservoirs to more than the average portion of runoff. The early estimates had of necessity considered only *average* rainfall distributions.

Reservoir No. 17, Sandstone Creek, April 30, 1954. Potential flood water is held behind the earthfill dam and released (below) at a controlled rate of flow which can be carried in the stream channel.

But they came amazingly close to reality!

Speculation returned to what might have occurred if the flood reduction program had not been installed. Popular opinion ranged from high to fantastic. The program work plan was again consulted. It had been estimated that with conditions as they existed on the watershed before the program was installed the April storm would have flooded 2,160 acres and the May storm 2,110 acres. These figures indicated that 1,572 acres (2,160-588) were protected from flooding during the April storm and 1,910 acres (2,110-200) during the May storm.

Noting that the unequal distribution of rainfall caused small errors in the estimates of flooding, technicians wondered if this would cause more serious errors in estimating the much greater flows to be expected without the program.

Records of rainfall and runoff during these two storms now provide a factual basis for determining the rates and amounts of runoff produced on various portions of the watershed. Hydrographs of these flows during the May storm are plotted in their relative areal position on the schematic sketch of the Sandstone in Figure 3. If the reservoirs had not been constructed, these flows would have passed unrestricted into the stream channels. Their influence on streamflow together with that of similar flows from areas below the reservoirs, can be quite accurately determined by a mathematical calculation commonly referred to as "flood routing."

One can readily see that a stream must have water in it before flow can occur and that the rate of flow increases as the depth and volume of water in the channel increases. Essentially, there exists a relationship between the volume of water in a section of stream channel and the rate of flow of water through the channel. This is referred to as the detention-flow relationship. The relationship can be computed for sections (reaches) of the stream from physical measurements of the channel, or it can be derived for the entire watershed drainageway by analyzing hydrographs of flow from some storm. Both methods were used to route the flows of the April and May storms on Sandstone as a check on each other and on the original estimates.

Flows entering the channel from various portions of the watershed are proportioned mathematically to flow through the channel and to detentions needed to produce such flows according to the detention-flow relationship. As a check on the flood-routing procedures, each method was used to route reservoir outflows recorded during the April and May storms, together with flows from areas without reservoirs to see if the resulting streamflow hydrographs agreed with those recorded by the U. S. Geological Survey at three different points in the channel system.

In Figure 4 it is evident that routing flows through successive reaches satisfactorily reproduced the hydrograph recorded by USGS at stations No. 1 and No. 3. The single routing method using one detention-flow relationship for the entire watershed also gives hydrographs which compare favorably with recorded flows as illustrated in Figure 5. The comparisions at station No. 2 were equally close but peak flows were too small to provide good illustrations.

On the strength of the accuracy implied by these comparisons, each method was used to route runoff hydrographs from various por-

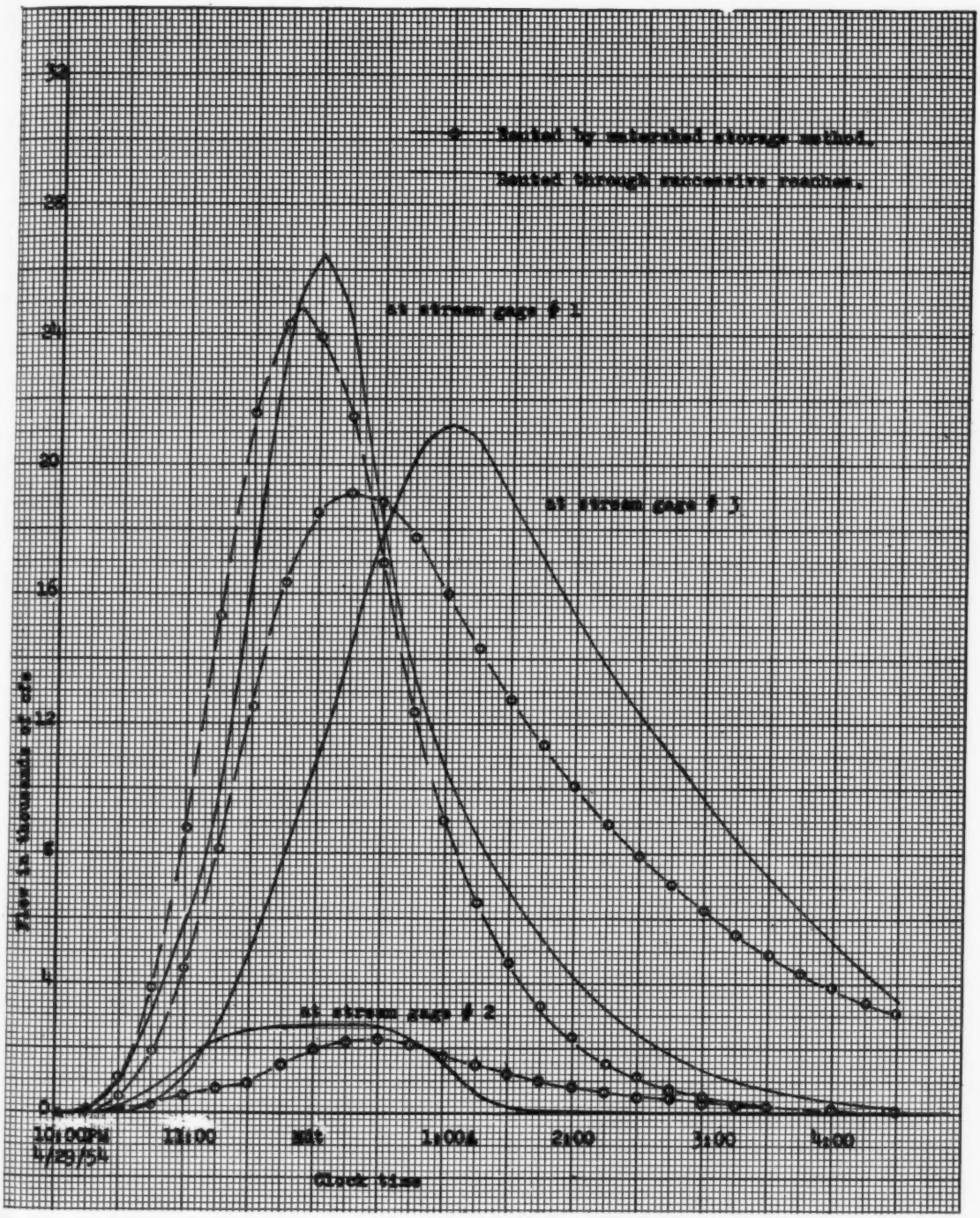

Routed by watershed storage method.
Routed through successive reaches.
at stream gage # 1
at stream gage # 3
at stream gage # 2
Flow in thousands of cfs
Clock time

Figure 6.—Hydrographs which would have occurred during the storm of April 29-30, 1954 if the reservoirs had not been installed.

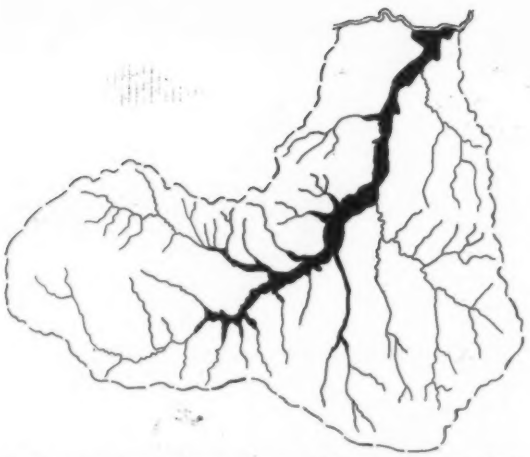


Figure 7.—Approximate areas which would have been inundated by the storm of April 29-30, 1954 on Sandstone Creek, Okla., if the detention reservoirs had not been installed.

tions of the watershed directly downstream without passing through the reservoirs. The resulting hydrographs at each of 3 gaging stations are plotted in Figure 6 for comparison of the 2 methods of routing. Although there is a discrepancy in time of occurrence, the peak rates of flow are not greatly different.

These two methods were then used to compute maximum stages and areas inundated at various points on the flood plain. The results are compared with original work plan estimates in Table 1.

Table 1.—Areas which would have been inundated without reservoirs as estimated by three methods

Method used in estimating	Area inundated	
	April 29	May 23
Method used in original work plan	2,160	2,110
Routed by successive reaches	2,461	2,370
Watershed detention storage method	2,335	2,259
Average	2,319	2,246

The discrepancies are not alarming. If confirmation is derived from consistency, these estimates of what would have happened without the program should be fairly reliable. Computed inundations which would have occurred during the April storm without the program are approximated in Figure 5. The May storm would have produced slightly different results, but the differences would be difficult to illustrate on such a small scale.

Some general concepts of the functioning of this flood-reduction program can be obtained by comparing Figures 1, 2, and 5. Figure 1 illustrates the area which was flooded during the 1934 flood, Figure 2 indicates a complete protection by reservoirs, and Figure 5 approximates the areas which would have been flooded by the April and May storms of 1954 if no program had been installed.

This article reports results obtained on Sandstone Creek watershed. Other watersheds spotted over the nation have been similarily treated and equipped with recording instruments. Should a flood-producing storm occur on one of the treated watersheds, the records obtained will be studied and analyzed to verify or improve on the technical methods so vital to successful flood reduction programs.

CURVING ORCHARD.—The first orchard on the contour in the Franklin Soil Conservation District is the work of William W. Hamilton, who farms near Athol, Mass.

Hamilton had an abandoned 9-acre field that he wanted to put to work. To prevent erosion caused by water flowing down from higher land, he built a 400-foot diversion terrace with tractor and plow. An SCS technician laid it out. He seeded the terrace to a sod-forming grass so that it would carry water safely around the field.

With the diversion terrace established, Hamilton last spring laid out 2 acres of the 9-acre field in contour rows. He planted pear trees and small fruits. The rows hold rain long enough for it to sink into the soil where it can be used by the trees.

Hamilton plans to build a 1,200-foot diversion terrace soon and to contour the rest of the field.

—EDWARD G. KONIECZNY

HORSES AND CONSERVATION

(Continued from page 74)

Nurserymen say horse-cultivation offers less hazard to valuable plants. Truck gardeners value the animals for "stop-and-go" field work.

More grass may save the horse from becoming a zoo oddity. Only 3 million of them are still working for American agriculture.

Chalk-Talker for Conservation

"Anybody here seen Kelly?" asked a manufacturer's representative following a knife-and-fork meeting in Minneapolis. "If not, you've missed something—he's in a class by himself."

THIS sentiment has been echoed for so many years that it seems important to make mention of this man in SOIL CONSERVATION Magazine, along with other forces making for an understanding of land problems in our Nation.

Tom Kelly was a newspaperman, art director, and cartoonist in St. Louis and Minneapolis. But more than 20 years ago he graduated to the broader field of conservation. Always a lover of the land, he was too distressed with the abuses he saw in forests and fields to confine his special talents to a city studio. For a time he was with the Minnesota Department of Conservation. For several years in the forties he served on the educational staff of the Soil Conservation Service in the midwest. Even here he found it impossible to do his labors quietly and unobtrusively in office or classroom. People were always urging him out to "make a speech." Kelly—Irish though he undoubtedly is—found it impossible to talk without using chalk and arm motion, a big sheet of paper and fervent enthusiasm. It soon became apparent that that suited his audiences first rate—it was the informal chatter *plus* the clever drawings that intrigued them!

The demands finally became so repetitive that Kelly at last gave up to the inevitable. He kissed his job goodbye and admitted he might just as well devote his whole time to telling his message to civic clubs, schools, and conventions wherever the cause of conservation was waiting for a spark to be struck.

Tom Kelly, who makes his home in Milwaukee, has been ranging the country ever since, with speaking dates that have carried him from one end of the country to the other. His jaunts now have totaled something more than a quarter million miles. At each stop he has put his idea across by drawing a few lines, raising his eyebrows, rolling his eyes, gesturing with chalk-smudged forefinger, even interrupting himself to tell a story. He likes to regard himself as "a vehicle to carry a sound philosophy of conservation."

Chalk-talker at work.

Wherever Kelly has been "seen" he has left a trail of new adherents to the cause of soil, water, forests, and wildlife.

OUTDOOR LABORATORY ASSURED.—The campaign to purchase and preserve the unique, virgin tract of native hardwood timber known as Mettler's Woods near New Brunswick, N. J., went over the top when the United Brotherhood of Carpenters and Joiners of America contributed a check for $75,000. William Cole, secretary of the Citizen's Committee for the Preservation of Mettler's Woods, said that the surplus would provide a "captial fund for maintaining and operating the tract . . . considerably larger than originally planned." The 136-acre area will be administered by Rutgers University as an outdoor scientific laboratory.

EFFECT OF NITROGEN.—Oklahoma wheat responds well to nitrogen fertilization, according to Eck and Stewart of the Oklahoma Agricultural Experiment Station. Significant increases in yields were obtained with applications of nitrogen at rates up to 80 pounds per acre. The most economical rate, 40 pounds per acre, gave an average increase of 10 bushels per acre at 7 of 8 locations in western Oklahoma.

Working Shoulder-to-Shoulder in he

HERE'S a story that tells how farm people and their local, state, and national agencies are working together to solve many a problem of land use and soil and water conservation. It's a story that's typical of what is going on just about everywhere in our States and Territories. It comes from Maryland, where soil and water problems have confronted landowners since the very first settlements in 1631. Early accounts here recognize the silting of streams and bays which impaired boat traffic, the ravages of droughts and floods, the depletion of soil fertility, and other problems of the land which have a familiar ring today. These problems certainly are not new, but the technology and the methods people are using to cope with their situations are strictly modern.

Maryland was one of the first states to enact district enabling legislation. That was in 1937. In the 18 years that have followed remarkable progress has been made in the conservation of soil and water resources. Cooperation and teamwork are as much responsible as the improved technology.

Maryland is one of the smaller states. It contains less than 1 percent of our country's farms and farmland. It does, however, hold an unusual variety of land and water problems which call for a wide range of answers. For example, on the coastal plains of the Eastern Shore the drainage of land suited for agricultural use is of high importance, together with correct maintenance once such land is drained.

BY
JOHN
W.
BARNARD

Here group cooperation is essential to success. Broiler production is a leading enterprise, which poses its own special questions. Cultivation of high quality tobacco on short, steep slopes in southern Maryland makes erosion control imperative. Dairying, livestock raising, and general farming predominate in the Piedmont Plateau and the Great Valley; here attention must be given to erosion control and water conservation on cropland, and to pasture improvement and management. In the westernmost counties good land use, cropland conservation measures, pasture and woodland management press for attention. Drought experiences have whipped up interest in supplemental irrigation throughout the State.

Thus we catch a glimmer of a few of the major problems which confront even a small state, and begin to see the need for local pro-

Combining spring oats in contour strip on farm of Andrew J. Young, Harford County, Md.

Note.—The author, formerly State Soil Conservationist, is head, conservation needs section, SCS, Washington, D. C.

in the Old Line State

sture improvement and cropland conservation are paying handsome dividends on thousands of Maryland farms.

grams adapted to local conditions. Supervisors of the soil conservation districts have taken the lead in developing and carrying out imaginative conservation programs with technical and financial help from many institutions and many units of government. Perhaps the degree of cooperation required for group drainage is greater than for some other conservation activities. For that reason a brief explanation of group drainage work may be of interest.

The State's drainage law was revised in 1941 to provide a fairly simple method of organizing tax ditch associations. These associations have tax powers, the right of eminent domain, and other features which enable them to function effectively. Eighty-three group drainage enterprise jobs have been planned by Soil Conservation Service technicians assisting soil conservation districts.

County agents and the extension drainage engineer have done much of the organizational work. County commissioners have aided many times by direct financial assistance, by necessary highway or bridge relocations, and in some counties by providing draglines and other heavy equipment. Of course, the local landowners bear a large part of the cost. Agriculture Conservation Program Service cost-sharing has aided greatly on individual farm drainage work, as well as by pooling agreements on small group jobs. Almost 300 miles of ditches have been excavated, involving several million cubic yards of earth. *Wet lands better suited for waterfowl or other wildlife never are recommended for drainage. There are about 300,000 acres of such land of which two-thirds has moderate to very high value for waterfowl. Where areas suitable for waterfowl have been involved adequate measures for protection of the birds have been taken.*

An outstanding example of one group operation is the Pocomoke River Project, one of the largest drainage enterprises which SCS has assisted. As early as 1840 the Maryland Legis-

Hedge planting is one of the many practices to encourage wildlife which are an essential part of a good conservation program.

lature passed the first "Act for clearing out the Pocomoke by means of a lottery." The job still had not been done by 1912 when the legislature appropriated $250,000 for dredging the river—a measure that was vetoed by the Governor. This work was finally completed, however, in 1946 through the efforts of the Wicomico and Worcester County Commissioners, the Pocomoke River Tax Ditch Association, the State of Maryland through direct appropriations and the services of the state drainage engineer, and technical assistance by the Soil Conservation Service through the Wicomico and Worcester Soil Conservation Districts. Labor for clearing was furnished by a CCC and later a CPS camp. The county agents in the two counties led the educational program. Teamwork thus accomplished a conservation job that has added millions in farm income. Over 80,000 acres of the watershed is in Maryland, with an additional 15,000 in Delaware—41,000 acres in cultivation.

Most of the conservation work is not so spectacular as group drainage. But the same sort of cooperative effort has been at work on individual farms. About 40 percent of Maryland's farm operators are district cooperators; they operate 50 percent of the State's farmland. Basic conservation plans have been developed for over two-thirds of them. Conservation accomplishments on the land have been and are continuing at a high rate. We shall attempt in the following paragraphs to explain how teamwork has helped.

Most of the districts have conducted an aggressive educational and informational program. This has served to impress landowners with the need for action and to explain how the district could help on conservation problems. Supervisors have received assistance with this phase of their program from many sources: press, radio, and television; farm organizations, particularly the granges and farm bureaus; Friends of the Land; the Extension Service through its county agents, extension soil conservationists, and other specialists; the vocational agriculture departments; fish and game clubs; banks and bankers' associations; state and federal conservation agencies, among them the Maryland Game and Inland Fish

"Before" and "after" views of a group drainage job in Worcester County, Md.

Commission, and the Maryland Department of Forests and Parks; the Agricultural Conservation Program Service, and the Soil Conservation Service. There are other forces, also, which aid in this work. The extension soil conservationist has assisted the curriculum committee of the State Board of Education with teaching aids and in distribution of teaching materials. The Committee for Conservation Now, a private organization, has done much to publicize the need for conservation. Private industry, fertilizer manufacturers, railroads, and others have been active.

The need for development of a basic conservation plan, rather than unrelated practices, has been emphasized throughout. Results from conservation farming in terms of yields and increased efficiency are also publicized, as well as benefits to the general public.

The State Soil Conservation Committee has been a positive force here, under the leadership of Dr. T. B. Symons, Dr. William B. Kemp, and the present chairman, Dr. Gordon M. Cairns. The committee's current State appropriations are $80,000 a year, most of which goes to district supervisors for expenses.

This is typical of the farm drainage problem on Maryland's Eastern Shore.

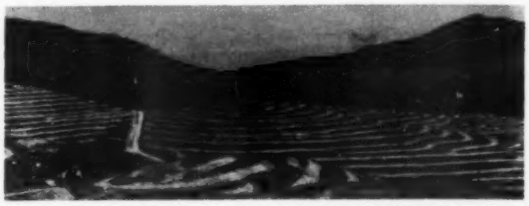
The State Association of Soil Conservation Districts, under the past leadership of Walter Burall, William Powel, and presently under Harry Reick has well served the interests of districts. On recommendation of the State Association, the State Soil Conservation Committee, and the Maryland Farm Bureau, a joint resolution was passed by the legislature for the study of water problems. Reick is chairman of this study group, which represents several segments of the state's economy and is indicative of the interest in arriving at an answer to the pressing water problems of the state.

To assure sound technical recommendations for proper land use and supporting conservation treatment, technical guides are drawn up by Soil Conservation Service technicians for their use in assisting district cooperators in developing conservation farm plans. These guides are prepared with the help of representatives of the Maryland Agricultural Experiment Station, extension specialists and county agents, the Department of Forests and Parks, and the Game and Inland Fish Commission.

Part of the conservation job at Baltimore's new airport was the establishment of ornamental shrubs on banks along the ramp leading to the upper level, in cooperation with the Anne Arundel County Soil Conservation District.

Fact Sheets issued by the Extension Service, particularly those of the agronomy department, have stressed the need for soil and water conservation in their recommendations. Other departments of the College of Agriculture have had a direct hand in the solution of conservation problems. An example is a guide for sprinkler irrigation recently developed cooperatively by several departments of the college, the Agricultural Research Service, and the Soil Conservation Service.

A number of research problems have been tackled and solutions reached through cooperation of the last three agencies.



Most new orchards in the state are planted on the contour.

The Department of Forests and Parks and the Game and Inland Fish Commission assist district cooperators by furnishing trees, shrubs, and seeds, and in planting. The Department of Forests and Parks also assists in marking woodlands for harvest and other cuttings. The Game and Inland Fish Commission furnishes fish for stocking ponds and helps with other features of the plan relating to wildlife conservation.

Most of the conservation work requiring heavy equipment is done by private contractors. Most districts have small equipment which is available for use of cooperators at reasonable rental rates. The Mardelva Farm Equipment Dealers Association has been a strong supporter of soil conservation districts. Credit agencies, both private and public, have encouraged farmers to adopt soil and water conservation programs. The Farmer's Home Administration has encouraged borrowers to cooperate with their districts.

Public Law 566, 83d Congress—the Watershed Protection and Flood Control Act—offers still more opportunities for cooperative endeavor. This act provides a basis for Federal participation and assistance in carrying out

Area in Carrol County, Md., before conservation—1937.

After conservation practices were put in effect—1952.

works of improvement for flood prevention and agricultural phases of the conservation, development, utilization, and disposal of water in a watershed. Rural and urban folks have a chance to work together in dealing with problems which affect both—a real challenge to all.

Here, too, soil conservation district supervisors are exerting a vigorous leadership. Several applications for planning assistance have already been received by the State Soil Conservation Committee, the state agency which receives such applications and sets up priorities, and surveys are under way on three watersheds in the State.

The watershed approach used previously on watersheds for planning and applying conservation measures is being followed extensively under the new legislation. Watershed groups have varied in size from a few farms up to several hundred. In order for a drainage enterprise to succeed there must be group action in the watershed. Experience shows that similar group action is essential for solving erosion and other water problems.

The Interstate Commission on the Potomac River Basin has fostered the formation of watershed councils or associations. A good start has been made on the tremendous task of trying to clean up the Potomac River.

The districts have enjoyed close cooperation from municipal water companies. The protection of a municipal water supply, for example, is being carried out by the Washington Suburban Sanitary Commission and the Howard and Montgomery County Soil Conservation Districts. The commission furnishes water to suburban Washington. In the watershed area above the reservoirs an intensive program of treatment is being followed on sediment sources along highways and streambanks as well as on farmlands. The commission has contributed financially to the districts in this work as well as taken corrective measures on its own lands.

In making payments for conservation practices under the Agricultural Conservation Program, emphasis has been on fitting in permanent-type practices in the basic conservation plan for each farm.

A splendid program of highway erosion control is being carried out by the State Roads Commission. Water disposal systems are designed to protect farmlands as well as highways.

The Maryland Department of Mines, Geology, and Water Resources has the responsibility of approving farm pond and other water developments. Good working relationships exist between this department, the districts, and the technical agencies.

An annual event which sharply points up conservation work in the State is Maryland Land Week. This program, held in the fall, calls to the attention of all citizens of the State the need for conservation and improvement of soil, water, forest, and wildlife resources. While this is statewide in character, special emphasis is given each year to one geographic area comprising several counties. Exhibits, tours, newspaper articles, and events of interest reach thousands of people annually.

Many individuals and many agencies and groups have shared in the success of the program of soil and water conservation in the State. We have room here to name only a few. The soil conservation district supplies the focal point. If we will but multiply our efforts—nationwide—with all agencies pitching in as they have in Maryland we can be certain that conservation over a great part of the nation will become an accomplished fact.

A Study of Rain Storms

By LLOYD L. HARROLD

No. 9

This is the ninth of a series of articles to appear from time to time in explanation of the various phases of research being conducted by the Department of Agriculture on problems of soil and water conservation.

IN A RECENT national report on research needs, the Soil Conservation Service gave water problems a top priority, saying—

"As a result of the Nation's growing recognition of water problems and their importance, great new responsibilities have been added to the many in this field previously assigned to the Service. Accordingly, we place heaviest emphasis on the research needs associated with the program to control, manage, conserve, and beneficially use water. The Service is making use of all available scientific knowledge about this great resource. Great strides are being made toward our assigned objectives—protection of small watersheds, flood prevention, and better management and use of water on farms and ranches. However, progress could be speeded and costs of protective measures could be reduced if science brought about a better understanding of the principles of water behavior on watersheds and in the various soils. Also, in view of the fact that movement of water through a soil is one of the chief determinants of proper use and treatment of that soil, technicians in the field of soil and water conservation need to know as much as possible about the basic principles of behavior of water in soils."

There are only a few places in the United States where water behavior and land facts are being gathered. The Coshocton, Ohio, Station is one of them. It is operated by Agricultural Research Service, U. S. Department of Agriculture, in cooperation with the Ohio Agritural Experiment Station at Wooster.

The results of studies at this station point to fundamental relationships of climate, soils, and crops that dictate the behavior of water on land. The data in this article are used to illustrate the fundamentals and are not intended to reflect firm quantitative evaluations. The period of record is too short and the area studied too small for that. The relationships are not new. Some may seem elementary. Yet

Note.—The author is project supervisor, Soil and Water Conservation Research Station, Agricultural Research Service, U.S. Department of Agriculture, Coshocton, Ohio.

Laboratory analysis of field samples.

they are important because they tend to keep attention focused on the major factors of the soil- and water-management problem. Thus even with very little on-the-spot research data, one is less likely to underestimate or overestimate greatly the value of his conservation program, or to overlook the many opportunities of working with nature's ever changing processes.

First in the line of our search for fundamental knowledge of water behavior on the land, is a study of precipitation—nature's supply to the earth's surface. Wherever one finds the water problem, one can develop his own series of facts such as we have prepared for Coshocton and set forth here.

In the humid section of the country precipitation exerts perhaps the greatest influence in the soil and water conservation program. The annual amount of precipitation varies over the 22 states from about 20 inches in northern Minnesota to over 40 inches in Virginia. The normal distribution over the 12 months, however, appears to have a noticeable similarity throughout, greater monthly amounts falling in the growing season than in the dormant season. We recognize that this is desirable as in the growing season crops need more water and then, also, the soil reservoir ordinarily has plenty of space to store this storm rainfall.

Our further study of the relationship of precipitation to conservation involves the development of an understanding of the different characteristics of the dormant- and growing-season storm precipitation, as follows:

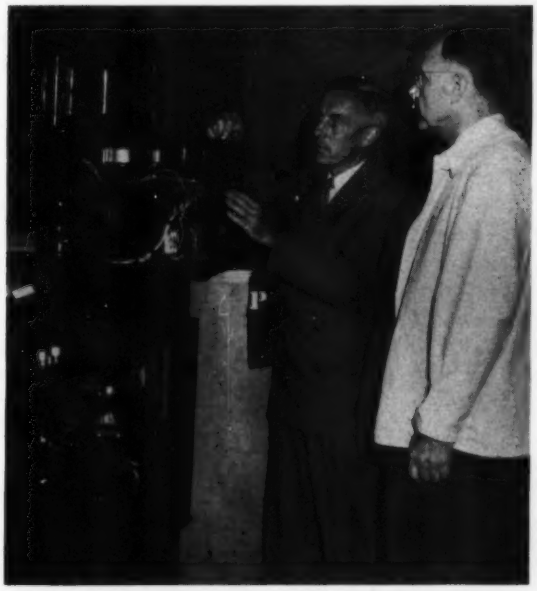
Table 1.—Precipitation characteristics

Characteristics	Dormant season	Growing season
Form	Solid and liquid	Liquid
Intensity	Low	High
Drop size	Small	Large
Duration of storm	Long	Short
Area of storm	Large	Small

Note.—Dormant season in this area is October-April and growing season, May-September.

These characteristics resulted in 85 percent of the annual water-born soil loss occurring in the May-September period. Observations were made on land fallow for 12 months. The energy of large raindrops falling on bare soil stirs up the soil. High intensity of rainfall causes much surface runoff which transports the soil loosened by raindrops.

In areas where freezing occurs, there is likely to be a period of high erosion when water runs off land slopes having a thin layer of thawed soil over a depth of frozen soil. Whatever the conditions, conservation technicians are en-



Harrold explains automatic weighing and recording operation of the giant lysimeter at Coshocton which measures moisture changes in the soil. Listening is Harold E. Pinches, assistant director of farm and land management research, Agricultural Research Service.

School essay contestants hear Lloyd Harrold talk on the proper management of soil and water.

couraged to develop for their own work area a chart of fundamental relationships like that given above. A clearer realization of the problem, field by field, and more substantial farm plans, will result as technician and farmer start with the fundamentals firmly established.

While on the subject of precipitation, it is well to consider its relationship to floods. The Ohio River Basin is commonly cited and the question is asked: "When do floods occur?" The answer invariably is "Winter and spring." Then we look at the breakdown of precipitation characteristics for the dormant season and ask: "Why?" The answer lies in items 1, 4, and 5. Snowmelt, along with rainfall, is a big factor at times. More often, however, the duration and areal extent of the storm are the major causative factors. A storm of several days soaks the soil, leaving little or no room for additional water absorption. Continued rainfall, therefore, must run off. Rainfall intensity is usually low (compared with summer rates), and the resultant runoff from watershed fields is at low rates. Flow from watersheds of a few acres or square miles is not excessive—usually well within the streambanks. Since the winter or spring storms cover most of the area of the big watershed, there are thousands of small streams contributing their flow at the same time to the big river channel. The channel isn't big enough to carry this water. Overbank flooding results.

Winter and spring storms saturate the soil, exhaust the soil storage space, and continued rainfall over large areas causes large river basin floods. This means that downstream flood-control works may be necessary to handle these excessive waterflows.

Attention is now directed to the growing-season floods—those that result from very high rainfall rates. Since the areal extent of these storms usually is small, the resultant flood area is small. See Table 2.

Table 2.—Seasonal occurrence of floods in the Ohio River Basin according to watershed size.

Drainage area in square miles	Percentage of time of maximum annual floods occurring in—	
	May-September	October-April
1	99	1
10	87	13
100	66	34
1,000	26	74
10,000	10	90
100,000	5	95

Surely, this distribution varies from region to region. Yet, the conservationist will be better qualified to discuss and develop flood-control programs when he realizes the basic causes of floods. Summer small-area floods in some areas are severe. In the Ohio region, the soil in this season usually is dry enough to provide a good-sized reservoir for water storage. Why not make better use of it? Let's look at the story of Johnson Run near Shenandoah, Iowa:

Area = 1,230 acres

Soil = Marshall silt loam, deep, well drained.

What happened:

1. Floods in Shenandoah were frequent and severe.
2. Now every farm in Johnson Run operates under a conservation plan with contour cultivation and 26 miles of level terraces.

3. In June 1947 when nearby streams reached all-time high levels, Johnson Run was 2/3 full.
4. In May 1951 with 2.41 inches of rain in 2½ hours, Johnson Run was ½ full.
5. In May 1950 with 5.11 inches of rain in 24 hours, Johnson Run was well within its banks.

We can also examine the records of a 43.6-acre watershed at the Coshocton Research Station. Before 1939, one-third of this area was in native hardwoods, and the remainder in gullied and abandoned cropland. In 1939 this poor land was reforested to pines which by 1945 had become fairly well established. The flood record on this watershed indicates that the 10- and 25-year flood peaks may be expected to be reduced about 20 percent and the 5-year peak about 30 percent as a result of this reforestation. These are growing-season floods. The results cannot be multiplied by a thousand to evaluate the effect of similar land use changes on a 43,600-acre area. There are many other factors which make this conversion from small area to large area impractical. We need to learn how to project information obtained on small experimental watersheds up to watersheds of several hundred square miles in size.

The technician, however, can learn much about his technical job and water behavior on the land by a study of the Coshocton small-watershed results. These watersheds are only 2 to 3 acres in size and are in a single crop in a particular season. A 4-year rotation of corn, wheat, and 2 years of meadow is followed. Conservation farming practices are compared with the conventional. The May-September 1948 results on 15 percent sloping land, as an example, are given below—

Conventional:

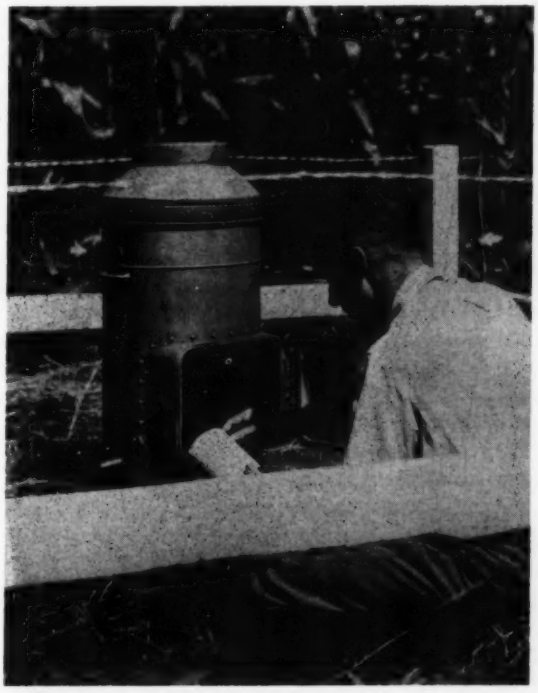
total runoff = 2.86 inches
peak rate = 3.90 inches per hour
soil loss = 23.0 tons per acre

Conservation:

total runoff = 1.14 inches
peak rate = 1.77 inches per hour
soil loss = 7.8 tons per acre

Such results are gratifying. Reduction in waste of water and soil of this magnitude should be accomplished on many more acres of our nation's farmland. Yet, in research, we have been looking for ways to accomplish even greater reductions on each acre of land. This end becomes more purposeful when we realize the high value of soil washed off the land. Research by R. B. Hickok and Helmut Kohnke on the West Lafayette, Ind., watersheds showed that the concentration of nitrates in soil washed off the land of 3 percent slope was 3 times that in soil remaining on the farm field. The ratio for potash was 17.

The effect of contouring was to slow down the velocity of runoff water, thus increasing the time of infiltration opportunity, reducing its cutting force, and reducing the ability of flowing water to carry soil torn loose by raindrops. The effect of mulches has been even more striking. Mulching begins its conservation job where the erosion process starts—at the surface. With other conservation research workers, we found that mulch on the surface of watersheds in corn reduced the damaging



Measuring precipitation—amounts, rates, distribution.

effect of raindrops and almost eliminated erosion and waste of water through runoff. Results for the May-September 1948 period are given below—

Mulch culture on contour:
total runoff = 0.05 inch
peak rate = 0.17 inch per hour
soil loss = 0.027 ton per acre

Just as we have seen a great change from straight-row farming to contour cultivation and stripcropping, we are likely to see equally great changes from clean tillage to mulch tillage and from finely-worked seedbeds to a minimum of seedbed preparation. Both of the latter changes are likely to have a significant effect on water behavior on the land. The Soil and Water Conservation Research Branch of Agricultural Research Service is attempting to determine how these changes can best be achieved under a variety of conditions.

So far, we have discussed basic principles of land surface treatment and their influence on water behavior. Next, we take up the soil profile, and its influence on the behavior of water on the land. Suppose we look at the storm of July 28, 1950. Rain of 1.1 inches fell on cornland of our conservation watershed in this one storm. Previous measurements had indicated that the unused moisture storage in the top 7 inches of the Keene silt loam amounted to 2.8 inches of water. Although this storage space was over twice as great as the amount of the rain, 0.5 inch of runoff occurred. Erosion totaled 2 tons per acre. No waste of water or loss of soil should have occurred. In fact, it did not occur on the mulched corn watershed. Available storage space was used.

There are, however, times when the readily available soil storage space is not sufficient to absorb all the rainfall, as illustrated by the storm of September 1, 1950. Rain totaled 4.3 inches. The 2.8 inches of storage space in the top 7 inches of soil was considered as readily available. Water penetrated to the 7-inch depth rapidly where the soil surface was protected from sealing. When fairly dry, the absorptive capacity of the topsoil is 6 inches per hour. At the same moisture content, the absorptive capacity of the subsoil is only 0.25 inch per hour. Therefore, you see why only that storage space in the topsoil is considered to be readily available.

With 2.8 inches of storage in 7 inches of topsoil, runoff from the 4.3-inch storm would be expected to be about 1.5 inches. For an eroded soil of 3-inch depth, storage space might be only 1.2 inches, and resultant runoff 3.1 inches. This is another good reason to stop erosion—to retain a good volume of storage space to absorb storm rainfall. Now let's raise our sights and shoot for attaining a greater effective depth of topsoil for quick water storage. Why not have 10, 12, or 14 inches of soil depth for rapid storage?

At the same moisture content indicated above—2.8 inches of water storage for a 7-inch soil depth—there might be 4.0, 4.8, or 5.6 inches of water-storage space for the three greater soil depths. It is estimated that if the effective depth of topsoil could be increased to provide a readily available soil reservoir space for 5 inches of storm rainfall, there would be almost no runoff periods in the growing season.

All this illustrates some of the important basic principles of water behavior on the land. Certainly, one must expect the quantitative relationships to differ from region to region and even from field to field. Yet, with these fundamentals firmly established in his thinking, a technician is equipped to recognize the problem on each field and to prescribe remedial measures. Furthermore, he is better able to estimate the magnitude of rainstorm effects in watershed programs. Accelerated research is a vital need.

SUMMER READING.—The Smokey Bear Vacation Reading Club for Orangeburg County got off to a bang with over 400 children registered in the City of Orangeburg alone.

The reading club was jointly sponsored by the South Carolina State Commission of Forestry, the State Library Board, and the Orangeburg Soil Conservation District supervisors.

The club got under way in June and ran through August. Each child enrolled reads 5 to 10 books on soil and water conservation. The literature was made available by the Orangeburg Free Library bookmobiles and by the library in Orangeburg.

The reading program was a natural way of using the soil and water conservation literature given by the district 4 years ago. Mrs. Georgie Adams says, "The children take to it like ducks take to water." The Orangeburg Soil Conservation District ordered $50 worth of additional literature as a prize and gift to the library when over 50 percent of the children read 10 books from the soil and water conservation file.

District Operates Own Nursery

Philip W. Spalding, at left, helps George Magnuson dig up red pine trees at the Dukes County Soil Conservation District nursery on Martha's Vineyard. Magnuson was to use the trees for replanting and reinforcing a windbreak on his island farm.

By EZRA I. SHAW

THE Dukes Soil Conservation District has set up its own nursery on Martha's Vineyard, Mass., to supply cooperating farmers with trees needed to reforest the land and supply windbreaks to take the punch out of soil-damaging gales.

Note.—The author is work unit conservationist, Soil Conservation Service, Vineyard Haven, Mass.

In 7 years previously district farmers had planted nearly a third of a million trees, using stock from the Big Flats nursery when it was operated by the Soil Conservation Service. How to keep up this good work with such stock no longer available became a problem.

Trees could be bought from the State nursery but the cost was increasing, said the district's annual report.

"The district has never charged cooperators for trees and the supervisors believe that such

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policy promotes the planting of more trees," said John G. MacKenty, treasurer.

Faced with the problem of finding a new source of low-cost trees, the district acted quickly. District Secretary Philip W. Spalding offered a part of his farm at West Tisbury for a nursery. Seedlings on hand and later received under an earlier order from Big Flats were put in the nursery. But last spring the district began planting its own trees, starting with Japanese black, red, and Austrian pine, and white and Norway spruce. Birds got away with some of the seed. But this temporary setback made the supervisors more determined than ever to make a go of the nursery.

"In 3 or 4 years the trees growing from seed should be ready for distribution to cooperators," MacKenty said.

The district is off to a modest start with its new project. But the supervisors believe that the nursery will become large enough to supply relatively low-cost trees to all cooperating farmers who have woodlands and windbreaks to take care of as part of their overall soil conservation programs.

SHOPWORK ON THE FARM. By Mack M. Jones. 616 pp. Illustrated. 1955. New York: McGraw-Hill.

THIS is an excellent and up-to-date revision of the very practical book with the same title and author which was printed in 1945. The new methods, machines, and gadgets developed for farm shopwork in the last 10 years are discussed in this edition. It is a readable and instructive book for those interested in almost any phase of farm shopwork except the repair of tractors, trucks, and automobiles. It should be an excellent reference or handbook for farmers, Vo-Ag teachers and students, and others interested in farm shopwork.

Chapter 1 gives practical information on how to plan and equip a farm shop. The succeeding chapters discuss methods and procedures for carpentry, cabinet work, metal work, soldering and welding, concrete work, rope and leather work, care and maintenance of farm tools and equipment, and include excellent pointers about selection and use of the many types of power tools and gadgets available.

The main emphasis throughout the book is placed on the use of correct methods and tools and why those methods or tools are best. If you want information on how to cut a rafter, sharpen a saw (any kind), mix and cure watertight concrete, build and maintain a forge, splice a rope or an electric wire, do electric-arc or oxyacetylene welding, repair leaky valves or faucets, install a simple shower bath, install a doorbell or buzzer, sketch or draw building plans, use a cold chisel, or do most other jobs commonly done by a farmer or home owner, this book is an excellent reference and guide. Safety precautions, especially in the use of power tools, are also stressed.

It is one of the McGraw-Hill Rural Activities Series, and is one of the best of that series. The author, Mack M. Jones, of the University of Missouri, has had 35 years of experience in teaching farm shopwork and has written many other practical books on this subject. He is an excellent amateur photographer and his daughter, Virginia, is an excellent pen and ink sketcher. Between them they have filled the book with hundreds of excellent photographs and drawings. In addition, Professor Jones has borrowed dozens of excellent photographs from the many manufacturers and distributors of equipment useful in a farm shop.

—TOM DALE